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ABSTRACT

The classroom behaviors of 129 Barbadian children (77 boys and 52 girls) ages 5 to 11 years, who had suffered from moderate to severe protein-energy malnutrition in the first year of life were compared with children with no history of malnutrition. Data were gathered from questionnaires administered to teachers who were unaware of the children's previous nutritional history. The results demonstrated that when compared to the matched sample of non-malnourished children, the previously malnourished children had attention deficits, reduced social skills, poorer physical appearance, and emotional instability. The behavioral deficits associated with prior malnutrition were independent of IQ and were experienced to a greater extent by boys. Socioeconomic conditions at the time of the study contributed little to the behavioral deficits of the previously malnourished children, as compared with the large contribution of the history of early malnutrition or the conditions producing it. (Author)

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The Influence of Early Malnutrition on Subsequent Behavioral Development

II. Classroom Behavior

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Abstract. The classroom behaviors of 129 Barbadian children (77 boys and 52 girls) aged 5-11 years, who suffered from moderate-severe protein-energy malnutrition in the first year of life were compared with those observed in children with no history of malnutrition. The data were gathered from questionnaires administered to teachers who were unaware of the child's previous nutritional history. The results demonstrated that the previously malnourished children had attention deficits, reduced social skills, poorer physical appearance and emotional instability when compared to the matched comparison children. These behavioral deficits associated with prior malnutrition were independent of IQ and were experienced to a greater extent by boys. Socioeconomic conditions at the time of the study contributed little to the behavioral deficits of the previously malnourished children, as compared with the large contribution of the history of early malnutrition or the conditions producing it.

INTRODUCTION

This is the second paper of a series dealing with the long-term consequences of early malnutrition on mental development and function in Barbadian school-children. A number of published studies in developing countries (Hertzig et al, 1972; McKay et al, 1978; Singh et al, 1977; Freeman et al, 1977, Ashem and Janes, 1978; Grantham-McGregor et al, 1979) provide a partial picture of the consequences to the developing child, mainly restricted to the area of cognitive function. The balance of this evidence demonstrates impairment of intellectual capacity, but this outcome is confounded by poverty and environmental deprivation. However, we report in the first paper of this series that early malnutrition can result in reduced IQ independent of socioeconomic factors. This measure of mental function is, nevertheless, inadequate to express the full range of factors impairing a child's ability to benefit from the educational process.

In order to examine more completely the various components of adaptive function following a history of moderate to severe protein-energy malnutrition (marasmus), we applied to our Barbadian children a protocol similar to that used by Richardson et al,(1972) to study classroom behaviors in malnourished Jamaican boys. In the current study, we examined the classroom behavior of

school boys and girls, aged 5-11 years, who have been exposed to severe marasmus in the first year of life in comparison with matched controls who had not experienced malnutrition and analyzed these data in relation to socioeconomic conditions. In later papers, we report academic performance and behavior at home in their relationship to antecedent malnutrition and to current socioeconomic and ecological conditions.

METHODS

Site of Study

Barbados was selected as the site for this study because the country has a National Nutrition Centre that has been following children with malnutrition as outpatients during their subsequent development for up to twelve years (Ramsey, 1980). This has generated good documentation on a population of approximately 2,100 children exposed to malnutrition. Over this period, only fourteen children have been lost to follow-up, six have emigrated, indicating considerable stability of the population. Several other features of this island population were favorable to our investigation. First, health care delivery is good. Almost all children are born in the Queen Elizabeth Hospital (QEH) or allied facilities, and well documented records of obstetric care are available in almost all cases. Furthermore, children are followed routinely

by local clinics and these records were made available when needed. Second, with respect to education, the Barbados has the highest literacy rate in the West Indies, with nearly all children attending school. Third, the population is homogeneous, ninety-five percent blacks of West African origin. Fourth, the country is small and readily accessible so that no group is overlooked.

Sample Selection

Exposed Series (n=129)

Of the 2,100 malnourished children followed by the Centre, only children with grade II-III (weight for age according to Gomez Scale) PEM in the first year of life were included. Following this episode, all children received routine health care and nutritional counseling. There were initially 141 children who met these criteria but twelve were eliminated because they were lost to follow up (seven cases) or their parents refused to grant permission (four cases) and in one case, the child had cerebral palsy. The distribution of the remaining 129 index children by age and sex is shown in the first paper of this series (Galler et al, 1982).

In order to exclude certain common determinants of mental deficiency, the following criteria were applied to both the exposed and non-exposed series:

(a) birth weight equal to or greater than five pounds

(b) no antecedent of prenatal or perinatal complications

(c) no history of high fever, convulsions, head injury or unconsciousness

This information was obtained from reviewing obstetric records of all mothers and medical records of all children.

Non-exposed Series (n=129)

These were selected by matching children from the exposed series by age, gender and handedness with children who had no antecedent history of malnutrition based on reviewing growth records from birth onwards. Whenever possible, classmates were used according to the above criteria, preferably by random selection if more than one classmate was available. However, thirty-seven cases of the exposed series were below the appropriate grade or in a special class, and controls were selected from the age-appropriate class. Children with no history of malnutrition were referred to as comparison cases.

Teacher Questionnaire

As part of a larger comprehensive study of the effects of malnutrition early in life, data concerning the behavior of each child in school was collected using a 30 item interview schedule

completed by the teacher (see Table 1). This was modeled after Richardson et al (1972). It should be emphasized that the teacher was unaware of the nutritional history of children in the study. Responses to the items on the questionnaires were dichotomous (yes/no), scaled (1=good through 6=poor) and open-ended. The schedule was pretested for 10 children not participating in the study, and revisions of wording and format were made as necessary.

The data obtained from the teacher questionnaire was collected between January and July, 1977. The interview was distributed by an experienced field worker who visited each teacher, and who reviewed the questions with the teacher to ensure that the teacher understood how to complete the interview schedule successfully. Other aspects of behavioral performance at home and at school are to be reported in subsequent papers.

Physical and Economic Resources in the Home

Data concerning the physical and economic resources in the homes of children used in this study is described in greater detail in the companion paper, Galler et al,(1982). Briefly, a 22 item interview was administered to the child's primary caretaker by a public health nurse. Items consisted of dichotomous (yes/no), forced choice and open-ended questions. The questionnaire was pretested and modified according to conditions present in Barbados.

Data Analysis

Reduction of the data obtained by teacher interviews was performed by factor analysis, using a principal component analysis with varimax rotation (Nie et al, 1975). Seven classroom behavior factors were identified by using eigen values greater than 1.00 (Table 2). These accounted for 68% of the total variance. Student's t-test of significance were used to identify significant factors. Factor scores were generated for each of the factors (n=258) and a 2-way (nutritional group x gender) analysis of variance (ANOVA) was performed on each significant factor (Table 3).

We have elsewhere described in detail (Galler et al, 1982) the analysis of the socioeconomic data. In order to determine the relative contribution of the current socioeconomic conditions and the history of marasmus to classroom behavior, stepwise multiple regression analyses were performed (Nie et al, 1975).

RESULTS

Classroom Behavior

The data used in these analyses were gathered from questionnaires administered to teachers asking them to describe the

behavior of previously malnourished children with a history of malnutrition and their matched controls.

A factor analysis was performed on the combined data from both the previously malnourished and comparison populations in order to identify groups of related behaviors, each factor referring to such a cluster of behaviors. Table 2 shows the seven factors emerging from the analysis of the data. As can be recognized in the table, the analysis produced groupings into well-recognized behavioral patterns including attention deficits (Factor 1); social interaction (Factor 2); physical appearance (Factor 3); emotional stability (Factor 4); special problems (Factors 5 and 6); and attendance (Factor 7). Thus, these groupings underscore the usefulness of the teacher questionnaires and the method of statistical analysis. The degree of association of each questionnaire variable within a factor is indicated by the fractional number (a factor loading or correlation); all behaviors with a low association value ($<.50$) were eliminated.

Analysis of variance was performed comparing factor scores of the previously malnourished population with those of the comparison population (Table 3). ANOVA performed for each factor score showed that children with a prior history of protein-energy malnutrition were significantly ($p=0.01$) disadvantaged as compared with their matched comparison on four of the seven factors, namely Factors 1, 2, 3 and 4, regardless of age. Factor 1

included a series of items most often associated with an attention deficit disorder including short attention span, poor memory, distractability and restlessness (Dykman et al., 1971; Conners, 1970; Eisenberg, 1964; Birch, 1964). Children with malnutrition in the first year of life had more deficits on this cluster than did comparison children without a history of malnutrition ($t=5.5$, $p < .01$). Factor 2 included items referring to the child's social interaction, namely the likelihood of the child to initiate conversation with teachers and peers. Again, children with histories of malnutrition were more likely to have reduced interactions than were their matched controls ($t=4.1$, $p < .01$). Factor 3 included items concerning the child's appearance at the time of the study, namely the teachers' observations concerning food intake, general health and sleepiness in the classroom. The children with prior malnutrition had lower scores in each of these items in comparison with control children ($t=3.1$, $p \leq .01$).

For each of the above three factors, boys and girls responded similarly. In contrast, a significant interaction between nutritional group and gender was present for Factor 4. This factor included items referring to emotional stability, namely the occurrence of frequent temper tantrums and crying. The source of the interaction was found to be a very low incidence of emotional instability among the control girls as compared with all other groups.

As described under Methods, thirty-six previously malnourished children and one comparison child were behind the expected school grade for age. To ensure that these children were not biasing the analysis, a second analysis identical to the one described above was performed excluding these children. The factor analysis yielded identical groupings of behavior to those obtained when the full sample was analyzed. ANOVA was also performed for the resulting factor scores, and these data appear in Table 3. As was the case for the full sample, Factors 1 (attention disorder), 2 (social interaction) and 3 (appearance) significantly distinguished between the previously malnourished and control children. In each case, the previously malnourished children were identified as having more behavioral problems than their matched controls. An apparent difference in this analysis, using the restricted sample, was the finding of sex related effects in three factors. This was a result of poorer performance of boys as compared with girls, irrespective of nutritional history. Furthermore, differences in Factor 4, referring to the presence of emotional instability were present only when the sample included children who were below the expected grade for age.

In a companion paper (Galler et al, 1982) we reported a reduction in IQ among children with previous malnutrition, such that 50% of this group had IQ scores less than 90 in contrast to only 17% of the comparison population. Since it

was possible that a reduced IQ was contributing to the behaviors observed in the classroom all analyses were repeated including only those children with IQ scores of 90 or above. This new analysis yielded similar results to those described earlier. Thus, we can conclude that deficits in classroom behavior are present even among children with average or above average IQ's.

These findings were examined in relation to cu ent socioeconomic status of the children in order to evaluate the degree of association. While testing the relationship of these conditions to IQ, we noted that there were differences in socioeconomic status between index and control populations, although these did not account for the IQ difference. Specifically, the previously malnourished children came from homes with fewer modern conveniences, with more crowded homes, and where father's employment was inferior. With regard to the relationship of socioeconomic status and classroom behavior, Table 4 displays the results of stepwise multiple regression analyses of the socioeconomic factors and nutritional history against each of the significant categories of classroom behavior, excluding Factor 4 since there was no independent effects of nutritional history for this category. For each classroom behavior factor, two sets of regression equations were generated. In the first set, the seven socioeconomic factors (described in the Methods section) were entered first, followed by nutritional history. In the second

set, the order of entry was reversed. As can be seen in the table, there was a highly significant correlation between nutritional history and the three classroom behavior factors. (This correlation corresponds to the R^2 value when nutritional history is entered first). The socioeconomic factors were rrelated only with Factor 3 (R^2 value when socioeconomic factors are entered first.) However, when the socioeconomic factors were partialled out (R^2 value when nutritional history is entered second on the equation), nutritional history still accounts for a significant percent of the variance in classroom behavior. These results underline the significance of the prior history of malnutrition and accompanying conditions in the early life of the child in modifying later behaviors necessary for school success.

The insignificant contribution of current socioeconomic conditions to the deficits in classroom behavior is further illustrated in Table 5, for the Attention Deficit factor. In this table, mean factor scores are presented for malnourished and control groups according to socioeconomic status, Thus, for each of the three socioeconomic factors which we described earlier as distinguishing between malnourished and control populations, we dichotomized the factor scores of the children into those falling above the mean or below the mean value. As may be seen, significant differences in the attention factor were present between malnourished and control groups regardless of socioeconomic

which made no contribution to the Attention Deficit factor. Similar results were observed for the three other classroom behavior factors.

DISCUSSION

The present study established more firmly than previous studies the long-term consequences of early malnutrition on classroom behavior. The reasons for this include (a) the socio-economic and social homogeneity of the population of Barbados; (b) the unique availability of complete records of prenatal care and birth from a single central hospital, followed by growth records and the identification of notifiable malnutrition according to grade of severity in the pre-school years through a National Nutrition Centre; (c) the high proportion of children (98%) attending school and the cooperation of the school staff in evaluating them. No other study has had the advantage of such favorable conditions for following the sequelae of early malnutrition.

The nearest approach to our data is the study Richardson (1972; 1980) conducted in Jamaica. However, Richardson's study was confined to Jamaican boys severely malnourished in the first two years of life in contrast to our series, malnourished in the first year. Richardson's data confirms some of our findings, namely that the previously malnourished children had shorter at-

tention spans, poorer memory, were more distractable than well-nourished controls and additionally had poorer social relationships.

Using statistical techniques in which classroom behaviors were analyzed for clusters of related behaviors (factors), our results provide a more comprehensive picture of the previously malnourished child. Thus, we have described the relationship of early malnutrition to later behavioral development and the relationship of this to environmental factors.

First, deficits in classroom behavior were present in the malnourished group irrespective of IQ, which we have reported (Galler et al, 1982) as being reduced in these children. Second, our findings expand to females the picture of the malnourished child drawn by Richardson. They show that many behavioral deficits following malnutrition are experienced by both sexes. However, girls, whether malnourished or not, had fewer deficits in classroom behavior than boys in contrast to IQ performance for which both sexes showed reduction to a similar level associated with a history of malnutrition. Third, of particular interest is the grouping of behaviors in Factor 1 and their significant relationship to an early history of malnutrition. Poor attention, impaired memory, easy distractability, poor school performance and restlessness resemble the syndrome of attention deficit disorder.

This constellation of behavioral characteristics were seen even when children with IQ's less than 90 were excluded from the analyses. This syndrome has frequently been associated with abnormal perinatal events, such as hypoxia. This implies that malnutrition in the first year of life should be added as a further potential association with factors causing attention deficit disorder. More rigorous study of this disorder for such as association is desirable. Fourth, by restricting the sample to only children in the correct grade for age, any evidence of a relationship between early malnutrition and emotional instability (Factor 4) was eliminated. Thus, emotional instability emerges in this group when the insult of early malnutrition results in a delay of one or more years in school.

Finally, as wes the case for IQ, current socioeconomic status was not related to deficits in classroom behavior. However, the history of marasmus early in life, whether directly or from concommitant associated factors such as impaired bonding, hospitalization, etc., accounted for all of the difference between groups for factors 1 (Attention Deficit), and 2 (Reduced Social Interaction) and for a component of factor 3 (Physical Appearance). More study of the early conditions related to the occurrence of marasmus may identify significant causal factors, as discussed in our companion paper (Galler et al, 1982).

The lack of impact of current socioeconomic status contrasts with studies elsewhere. This may result from a generally better economic standing of the Barbadian population, and the homogeneity of the population. This has allowed us to separate out significant factors associated with the early history of malnutrition as important contributors to later behavioral characteristics.

TABLE 1

Questionnaire of Classroom Behavior
Administered to Teachers

1. How well does child pay attention to you in class?
2. How obedient is he/she? Does the child do what he is told?
3. How cooperative is he/she with you?
4. How good a memory has he/she?
5. How easily is the child's work disturbed by distractions such as noise, commotion in the classroom?
6. Does he/she ever make suggestions or talk to you without being specifically asked for information?
7. Which of the following statements best describes how he/she gets along with other children?
   - Other children always like him/her and he/she is friendly with other children.
   - He/she manages well most of the time with other children.
   - He/she is quiet and withdrawn and has little or no contact with other children.
   - He/she is disliked by other children and gets into trouble with them.
8. Does he/she have any special problems?
9. If yes, check which of the following apply (can be more than one problem area)

   Conduct

   Immaturity

   Social Relations

   Learning

   Other (write in)

Table 1 (continued)

10. Does he/she have any behavior or conduct problems? Please consider not only problems that interfere with his/her class work or cause trouble but also where he/she is withdrawn, shy, or hard to reach.

11. If yes, please describe.

12. Does he/she ever lose emotional control? (e.g. Does he/she attack other children? Does he/she cry in class?)

13. If yes, please describe.

14. Is he/she usually fidgety and unable to settle down in the classroom?

15. Does he/she ever wet himself/herself at school?

16. Does he/she ever soil himself/herself at school?

17. Do you have any evidence that he/she comes from a problem home? (e.g. dirty clothes, lack of cleanliness, contacts you have had with his/her family.)

18. If yes, please give your evidence.

19. Do you have any evidence that he/she is not getting enough to eat?

20. If yes, please give your evidence.

21. Does he/she often seem sleepy and have a hard time staying awake?

22-29. Please fill out the following form to give us a picture of child's school performance.

Report of Term 1

Report of Term 2

30. Please check whichever statement here applies to child's overall school work.

He/she is outstanding

He/she is very good

He/she is average

He/she is below average

He/she is poor

He/she is severely backward

TABLE 2

Factor Analysis of Teacher Questionnaire

Question *	FACTOR 1 (Attention Disorder)	FACTOR 2 (Social Interaction)
(1)	.80 Poor Attention	(6) .75 Does not initiate conversation with teacher
(30)	.75 Poor School Performance	(7) .67 Poor peer relationships
(4)	.68 Poor Memory	
(5)	.64 Easily Distracted	
(3)	.62 Not Cooperative	
(29)	.62 Low Class Rank	
(2)	.61 Not Obedient	
(8)	.61 Presence of Special Problems	
(14)	.63 Restlessness	
	FACTOR 3 (Physical Appearance)	FACTOR 4 (Emotional Stability)
(19)	.68 Not getting enough to eat	(12) -.94 Poor emotional control
(22)	.68 Poor general health	(13) -.93 Emotional outbursts
(21)	.64 Sleepy in class	
	FACTOR 5 (Special Problems I)	FACTOR 6 (Special Problems II)
(15)	-.83 Soils	(10) -.88 Behavioral problems
(16)	-.81 Wets	(11) -.53 Specific problems
	FACTOR 7 (Attendance)	
	.80 Days in school	

*Refers to question in interview schedule

TABLE 3

Comparison of Classroom Behaviors Between Index and Comparison Children (ANOVA)

n = 258	df	Factor 1	Factor 2	Factor 3	Factor 4
Main Effects	2	17.0 [c]	9.9 [c]	5.1 [b]	NS
Nutrition Group	1	31.8 [c]	16.9 [c]	9.8 [b]	NS
Gender	1	NS	NS	NS	3.9 [a]
Nutritional Group x Gender	2	NS	NS	NS	4.7 [a]

n = 184	df	Factor 1	Factor 2	Factor 3	Factor 4
Main Effect	2	15.9 [c]	4.3 [a]	5.6 [b]	NS
Nutrition Group	1	27.2 [c]	4.3 [a]	8.9 [b]	NS
Gender	1	4.9 [a]	4.4 [a]	NS	4.1 [a]
Nutritional Group x Gender	2	NS	NS	NS	NS

$p < .05$ [a]
$p \leq .01$ [b]
$p \leq .001$ [c]

TABLE 4

Multiple Regression Analyses of Classroom Behavior with Socioeconomic Factors and Nutritional History

Dependent Variables	Independent Variables (df)	
	Entered First: Nutritional History (1)	Variance added by: Socioeconomic Factors (7)
Classroom Behavior (N = 255):		
Factor 1 (Attention Disorder)	.12 [c]	NS
Factor 2 (Social Interaction)	.04 [c]	NS
Factor 3 (Physical Appearance)	.05 [c]	NS

	Entered First: Socioeconomic Factors (7)	Variance added by Nutritional History (1)
Classroom Behavior (N = 255):	R^2	R^2
Factor 1 (Attention Disorder)	NS	.10 [b]
Factor 2 (Social Interaction)	NS	.02 [a]
Factor 3 (Physical Appearance)	.06 [a]	.02 [a]

$p < .05$ [a]

$p < .01$ [b]

$p < .001$ [c]

TABLE 5

The Relationship Between Socioeconomic Factors and Attention Disorder (Class Behavior Factor 1)

Nutritional Group

Socioeconomic Status	malnourished	control	malnourished	control	malnourished	control
above group mean	-42 [a]	+30	-30	+33	-34	+34
below group mean	-26	+46	-35	+34	-32	+33
SES factors:	Household Items		Housing		Father's Work	
RESULTS OF ANOVA:	F-value		F-value		F-value	
Nutritional history	38.3	$p < .05$	34.1	$p < .05$	36.5	$p < .05$
SES factor	1.9	NS	0.0	NS	0.0	NS
interaction	0.0	NS	0.0	NS	0.0	NS

[a] Factors scores were multiplied by 100 for graphic presentation only

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